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NEW RESONANCES AT BELLE*

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The Belle detector at the KEKB asymmetric e^+e^- collider is not only an excellent experimental environment for the measurements connected to the neutral and charged B mesons, but also a rich source of different hadronic states containing charm quarks. We present discoveries of new and property measurements of several recently observed such hadron states. Some of them pose questions regarding their nature and represent a challenge for the description in terms of QCD. Specifically we address the properties of D_{sJ} mesons, newly observed $X(3872)$ and $Y(3940)$ states, analysis of the hadrons produced in association with a $c\overline{c}$ system and searches for possible pentaquark states.

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1. Introduction

The KEKB asymmetric B meson factory [1] is operating in the National Laboratory for High Energy Accelerator Physics (KEK) in Tsukuba, Japan. Electrons and positrons are being collided at the center-of-mass (CMS) energy of about 10.6 GeV, corresponding to the mass of the $\Upsilon(4s)$ resonance. Beams of e^- with momenta of 8 GeV/c and of e^+ with momenta of 3.5 GeV/c intersect at a crossing angle of 22 mrad. The main objective of the Belle experiment, located at the e^+e^- interaction region, is a study of the CP symmetry violation phenomena [2] in the system of B mesons produced from the $\Upsilon(4s)$. Beside that a large variety of other interesting measurements is performed.

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Electron positron collisions at the above mentioned CMS energy are also an excellent source of other light and charm quarks, arising either directly from the e^+e^- annihilation or from the decays of B mesons. In this paper we address some intriguing discoveries of new hadronic states, observed by Belle and other collaborations. In the following section the KEKB collider and the Belle detector are shortly described. The next four sections are in turn devoted to the measurements of D_{sJ} mesons properties (3), observation of the so called $X(3872)$ resonance with a yet undetermined quark structure and the evidence of an $\omega J/\psi$ resonance called $Y(3940)$ (4), measurements and surprises in the study of the hadronic system recoiling against the $c\overline{c}$ system produced in e^+e^- annihilations (5) and at last but not least the search for possible pentaquark states using different decay modes and techniques (6). In the last section we give references to a more detailed results for an interested reader and a short conclusion.

2. Experimental environment

The luminosity of the KEKB collider has been steadily increasing since the start of operation. Recently the highest luminosity ever reached in e^+e^- collisions was achieved, exceeding 1 fb^{-1} per day. This corresponds to more than 10^6 $B\overline{B}$ pairs recorded by the Belle detector each day. The integrated luminosity of the total sample amounts to about 400 fb^{-1}. Most of the results presented here are obtained on a smaller data sample as noticed in each section.

The central region of the Belle detector [3] is placed within a superconducting solenoid providing a homogeneous 1.5 T magnetic field. The Silicon Vertex Detector (SVD) is situated closest to the e^+e^- interaction point. It enables a separation of the two B meson decay vertices with a sufficient precision to perform precise measurements of decay time dependent CP violation effects. The Central Drift Chamber (CDC) is the main tracking device of the detector. The achieved precision on the component of charged track's momentum perpendicular to the magnetic field direction is about 0.4% for a 1 GeV/c track, roughly illustrating the performance of the CDC. Following in the radial direction is the Aerogel Cherenkov Counter (ACC) in which the Cherenkov effect is exploited for determination of particles velocities and by that of their masses. As a crude estimate we can quote the efficiency of identification for charged kaons of about 85% with a $\pi^\pm$ mis-identification probability of less than 10%. The Electromagnetic Calorimeter (EC) measures the energy of $e^\pm$ and photons and also serves as the identification device for these particles. Muons are detected in the $K_{\rm L}$ and Muon detector (KLM).

While a smaller sample of data is recorded at about 60 MeV below the mass of the $\Upsilon(4s)$ (continuum data) also in the on-resonance collisions $B\overline{B}$ decays can be well separated from the e^+e^- annihilations into u, d, s and c quark pairs. This is achieved by combining several observables separating the more spherical B meson decays (B mesons are produced almost at rest in the CMS) from the jet-like annihilation events [4]. B mesons are reconstructed using two kinematical variables, the beam constrained mass $M_{\rm bc} = \sqrt{(E_{\rm CMS}/2)^2 - (\sum_i \vec{p}_i)^2}$ and the energy difference $\Delta E = \sum_i E_i - E_{\rm CMS}/2$. E_i and $\vec{p}_i$ are the CMS energies and momenta of the selected B meson decay products, and $E_{\rm CMS}$ is the CMS energy of e^+e^- collision. For genuine decays of the B meson the $M_{\rm bc}$ distribution has a peak at about 5.28 GeV$/c^2$, the mass of the meson, and ΔE peaks at zero.

3. D_{sJ} mesons

Orbital excitations of $c\overline{s}$ bound system, D_{sJ} mesons, were first observed by BaBar and Cleo collaborations [5]. Two states with masses around 2320 MeV$/c^2$ and 2460 MeV$/c^2$ were reconstructed using their decays $D_{sJ}(2320)^+ \to D_s^+\pi^0$ and $D_{sJ}(2460)^+ \to D_s^{*+}\pi^0$ [1]. Radiative decay of $D_{sJ}(2460) \to D_s^+\gamma$ has first been reported by the Belle collaboration [6]. Analysis of 87 fb^{-1} continuum data under the $\Upsilon(4s)$ resonance offered the signals corresponding to the three mentioned decay modes of new mesons shown in Fig. 1 [7].

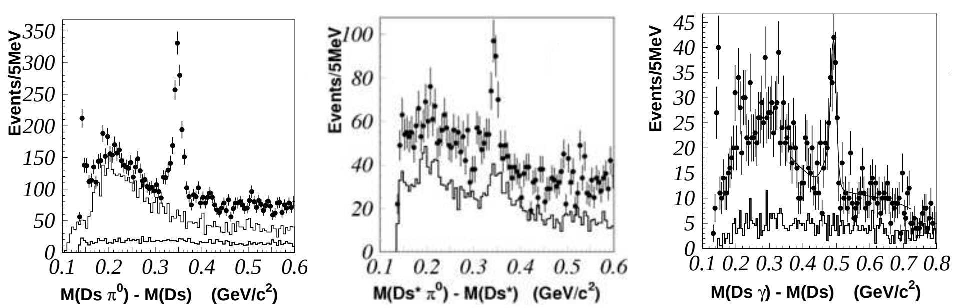

Fig. 1. Reconstructed mass difference between the D_{sJ} states and $D_s^{(*)+}$ for the $D_{sJ}(2320)^+ \to D_s^+\pi^0$ (left), $D_{sJ}(2460)^+ \to D_s^{*+}\pi^0$ (middle) and $D_{sJ}(2460) \to D_s^+\gamma$ (right) decays. Open histograms show contribution of $D_s^{(*)}$ side bands.

By fitting the distribution of the mass difference between the $D_{sJ}(2320, 2460)$ and $D_s^{(*)+}$ meson the measured masses are

[1] Charge conjugate states are implied throughout of the paper.

$$M(D_{sJ}(2320)) = (2317.2 \pm 0.2(\text{stat.}) \pm 0.9(\text{syst.}))\ \text{MeV}/c^2\,,$$
$$M(D_{sJ}(2460)) = (2456.5 \pm 1.3(\text{stat.}) \pm 1.3(\text{syst.}))\ \text{MeV}/c^2\,.$$

The widths of the signals are consistent with the experimental resolution and limits on the natural widths were placed at about 5 MeV.

Although the D_{sJ} states were naturally interpreted as P-wave excitations of the $c\overline{s}$ system with the total angular momentum of the light quark $J_q = 1/2$, their masses and widths are significantly lower than predicted in the potential models [8]. This has lead to speculations about new resonances being exotic mesons composed of four quarks or a DK molecule [9]. To further study the properties of these mesons that could shed light on their internal structure it was natural to search for their production in the decays of B mesons as well.

The associated production of $\overline{D}D_{sJ}$ production was first observed by Belle coll. [6]. The combined ΔE distribution for $B^+ \to \overline{D}^0 D_{sJ}^+$ and $B^0 \to D^- D_{sJ}^+$ decays in the signal region of M_{bc} and $M(D_{sJ})$ is presented in Fig. 2 (top) [10]. Using 275×10^6 recorded $B\overline{B}$ meson pairs the product branching fractions of individual decay modes were measured, *e.g.*

$$\text{Br}(B^0 \to D^- D_{sJ}(2320)^+) \cdot \text{Br}(D_{sJ}(2320)^+ \to D_s^+ \pi^0)$$
$$= (10.3 \pm 2.2(\text{stat.}) \pm 3.1(\text{syst.})) \times 10^{-4}\,.$$

In order to check the spin assignments of $J = 0$ and $J = 1$ for the $D_{sJ}(2320)$ and $D_{sJ}(2460)$, respectively, the distribution of the helicity angle, defined as the angle between the D_{sJ} momentum in the B meson rest frame and the D_s momentum in the D_{sJ} frame, was studied. Comparison between the measured values and MC expectations for different spin values are presented in Fig. 2 (bottom). Data clearly support the lighter meson to be the $J^P = 0^+$ and the heavier one the $J^P = 1^+$ state.

Apart from the D_{sJ} production in association with D mesons also $\overline{B}^0 \to D_{sJ}^+ K^-$ decays were observed at Belle [11]. This process is of great interest due to a completely different quark compositions of the final ($c\overline{s}s\overline{u}$) and initial ($b\overline{d}$) states. Possible Feynman diagrams for such a process are shown in Fig. 3 and describe a $W^\pm$ exchange, final state interaction or a speculative four quark structure of the D_{sJ} meson. A clear signal of $\overline{B}^0 \to D_{sJ}(2320)^+ K^-$, $D_{sJ}(2320)^+ \to D_s^+ \pi^0$ decays among 152×10^6 $B\overline{B}$ pairs can be seen in Fig. 4. The observed yield of B decays can be converted to a

$$\text{Br}(\overline{B}^0 \to D_{sJ}(2320)^+ K^-) \cdot \text{Br}(D_{sJ}(2320)^+ \to D_s^+ \pi^0)$$
$$= (5.3 \pm 1.4(\text{stat.}) \pm 0.7(\text{syst.}) \pm 1.4(\text{D}_\text{s})) \times 10^{-5}\,,$$

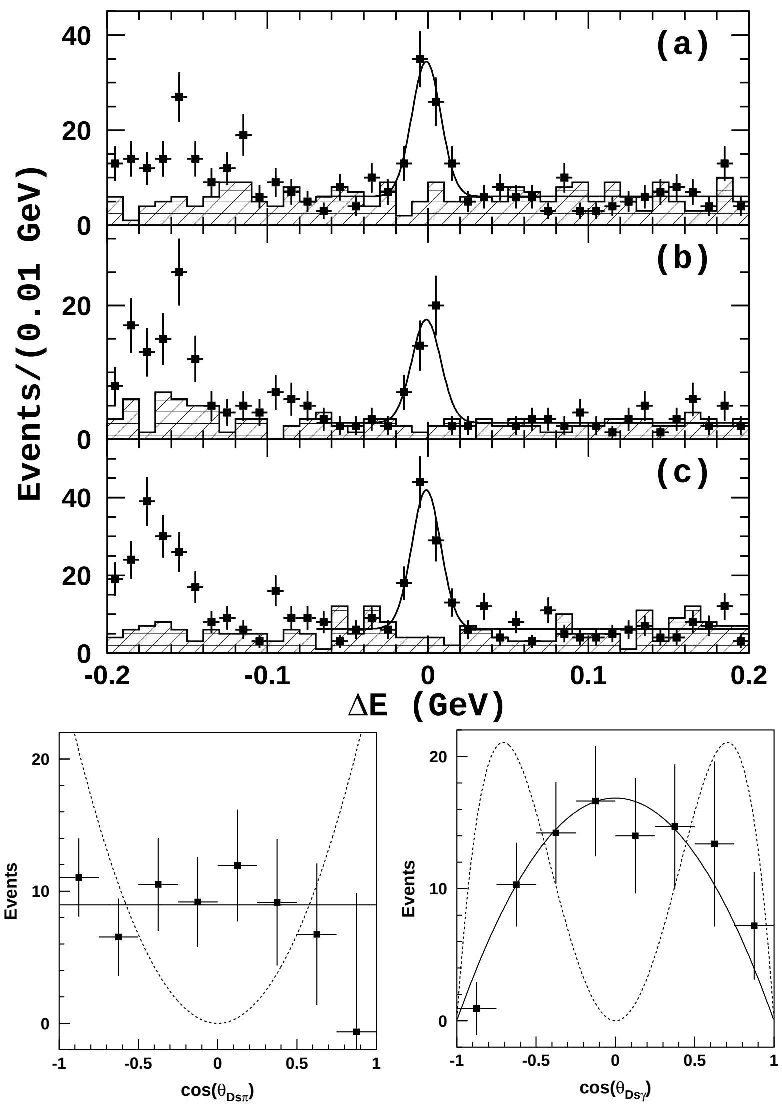

Fig. 2. Top: ΔE distributions for $B^+(B^0) \to \overline{D}^0(D^-)D_{sJ}^+$ decays in $D_{sJ}(2320)^+ \to D_s^+\pi^0$ (upper), $D_{sJ}(2460)^+ \to D_s^{*+}\pi^0$ (middle) and $D_{sJ}(2460) \to D_s^+\gamma$ (lower) decay modes. The shaded histogram shows the contribution from the $M(D_{sJ})$ side band. Bottom: D_{sJ} helicity angle distribution for $D_{sJ}(2320)^+ \to D_s^+\pi^0$ (left) and $D_{sJ}(2460) \to D_s^+\gamma$ (right) decays. Full lines show the expectations for the $J = 0$ and $J = 1$, while the dotted lines represent expectations for $J = 1$ and $J = 2$ states, respectively.

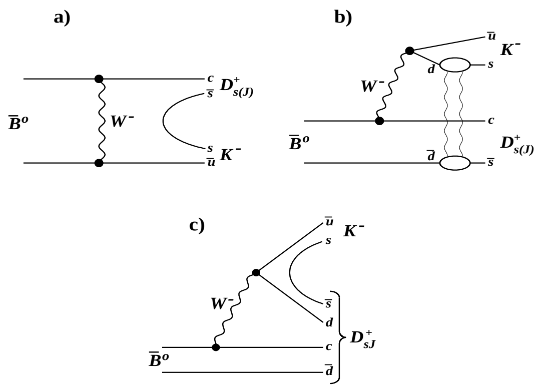

Fig. 3. Possible diagrams contributing to $\overline{B}^0 \to D^+_{sJ}K^-$: $W^\pm$ exchange (a), final state interaction (b) or four quark structure of the D_{sJ} (c).

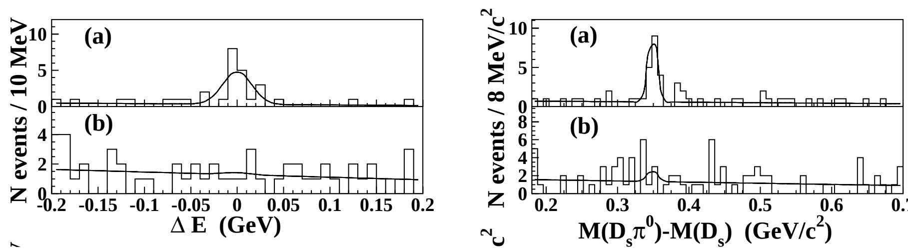

Fig. 4. ΔE (left) and $M(D_s\pi^0) - M(D_s)$ (right) for $\overline{B}^0 \to D_{sJ}(2320)^+K^-$ (top) and $\overline{B}^0 \to D_{sJ}(2320)^+\pi^-$ (bottom) events in the $M_{\rm bc}$ signal region.

where the last error is due to the uncertainty on the D_s branching fractions. No significant signal was observed for the $D_{sJ}(2460)^+K^-$ decay mode, nor for the $D^-_{sJ}\pi^+$ decays and the following 90% CL upper limits were derived:

$$\begin{aligned}
{\rm Br}(\overline{B}^0 \to D_{sJ}(2320)^-\pi^+) \cdot {\rm Br}(D_{sJ}(2320)^- \to D_s^-\pi^0) &< 2.5 \times 10^{-5}\,, \\
{\rm Br}(\overline{B}^0 \to D_{sJ}(2460)^+K^-) \cdot {\rm Br}(D_{sJ}(2460)^+ \to D_s^+\gamma) &< 0.94 \times 10^{-5}\,, \\
{\rm Br}(\overline{B}^0 \to D_{sJ}(2460)^-\pi^+) \cdot {\rm Br}(D_{sJ}(2460)^- \to D_s^-\gamma) &< 0.40 \times 10^{-5}\,.
\end{aligned}$$

Comparing the measured branching fractions of B decays to $D_{sJ}D$ and $D_{sJ}K$ with the similar ones involving the pseudo-scalar D_s one obtains

$$\begin{aligned}
\frac{{\rm Br}(\overline{B}^0 \to D_{sJ}(2320)^+K^-) \cdot {\rm Br}(D_{sJ}(2320)^+ \to D_s^+\pi^0)}{{\rm Br}(\overline{B}^0 \to D_s^+K^-)} &= 1.8 \pm 0.6\,, \\
\frac{{\rm Br}(\overline{B}^0 \to D^+D_{sJ}(2320)^-) \cdot {\rm Br}(D_{sJ}(2320)^- \to D_s^-\pi^0)}{{\rm Br}(\overline{B}^0 \to D^+D_s^-)} &= 0.13 \pm 0.05\,.
\end{aligned}$$

In the ratios the systematic errors due to the D_s branching fractions cancel out and the error shown is statistical only. $\mathrm{Br}(\overline{B}^0 \to D_s^+ K^-)$ is taken from [12] and $\mathrm{Br}(\overline{B}^0 \to D^+ D_s^-)$ from [13]. The difference of the order of magnitude suggest one still needs further investigations of the D_{sJ} system in order to understand the structure and the dynamics of these states.

4. $X(3872)$ and $Y(3940)$

In 2003 Belle discovered a new resonance decaying to $\pi^+\pi^- J/\psi$ [14]. It was seen as a small, but statistically significant peak in decays $B \to \pi^+\pi^- J/\psi K$, $J/\psi \to \ell^+\ell^-$. The updated measurement was performed on a data sample of 275×10^6 $B\overline{B}$ meson pairs [15]. From about 50 reconstructed events with a statistical significance above 10 σ (see Fig. 5 (left)) the mass of the resonance, called $X(3872)$, was determined to be $M_{X(3872)} = (3872.4 \pm 0.7(\mathrm{stat.}))$ MeV/c^2. The measured product branching fraction for the observed decay is

$$\mathrm{Br}(B \to X(3872)K) \cdot \mathrm{Br}(X(3872) \to \pi^+\pi^- J/\psi) = (1.3 \pm 0.3(\mathrm{stat.})) \times 10^{-5}.$$

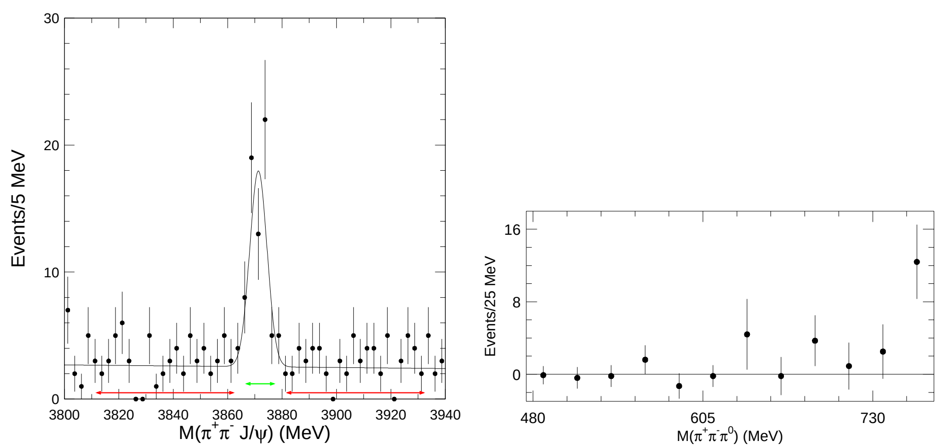

Fig. 5. Left: Fitted yield of B mesons in the decay $B \to \pi^+\pi^- J/\psi K$ in bins of $M(\pi^+\pi^- J/\psi)$. Right: Fitted yield of B mesons in the decay $B \to \pi^0\pi^+\pi^- J/\psi K$ in bins of $M(\pi^0\pi^+\pi^-)$.

At a first sight the $X(3872)$ might appear as an obvious candidate for one of the yet unobserved charmonium states, produced in B decays similarly as the $\psi(2s)$ in $B \to \pi^+\pi^-\psi(2s)K$. However none of the predicted charmonium states emerging as a possible candidate comfortably fits the up to date accumulated properties of $X(3872)$. Moreover, a close vicinity of the measured mass to the sum $M(D^0)+M(D^{*0})$ (within the measurement uncertainty) makes the newly discovered resonance a possible candidate for the two meson molecule.

The signal of $X(3872)$ has not been limited to $\pi^+\pi^-J/\psi$ decays. Final state with an additional neutral pion, $B\to\pi^0\pi^+\pi^-J/\psi K$, has also been studied. Limiting the invariant mass of the $\pi^0\pi^+\pi^-J/\psi$ system within three standard deviations around the $X(3872)$ mass, the yield of B mesons in bins of $M(\pi^0\pi^+\pi^-)$ for this decays is plotted in Fig. 5 (right). Since only in the highest mass bin ($M(\pi^0\pi^+\pi^-)>750\ MeV/c^2$) the signal with a significance larger than 6 σ is observed, it can be interpreted as a subthreshold decay of $X(3872)\to\omega J/\psi$. The ratio of branching fractions for the two observed decay modes of $X(3872)$ is

$$\begin{aligned}&\mathrm{Br}(X(3872)\to\pi^0\pi^+\pi^-J/\psi)/\mathrm{Br}(X(3872)\to\pi^+\pi^-J/\psi)\\&=1.1\pm0.4(\mathrm{stat.})\pm0.3(\mathrm{syst.})\,,\end{aligned}$$

the last error is mainly due to a possible non-resonant $B\to\pi^0\pi^+\pi^-J/\psi K$ contribution. This is in agreement with the predictions of the DD^* molecule model for the $X(3872)$ state [16].

Restricting the $M(\pi^0\pi^+\pi^-)$ in $B\to\pi^0\pi^+\pi^-J/\psi K$ decays to the vicinity of the ω mass a further study of the three body $B\to\omega J/\psi K$ decay was performed [17]. Fig. 6 (left) shows the Dalitz plot for the selected B decays. While the low $M(K\omega)$ region is populated with $B\to K^*J/\psi,\ K^*\to K\omega$ cascade decays, the number of B decays is estimated for higher values of $M(K\omega)$ as indicated in the plot. Fig. 6 (right) represents the B meson yield obtained by a simultaneous fit to the $M_{\rm bc}$ and ΔE distributions in bins of $M(\omega J/\psi)$. The lower curve shows the expectation for the phase space distribution; a strong enhancement of events is present at low mass values. The upper curve is the result of the fit using a sum of the phase space and an additional Breit–Wigner function to describe the data. The Breit–Wigner signal yield is found to be 58 ± 11 events (stat. significance above 8 σ) at a mass of $(3943\pm11(\mathrm{stat.}))$ MeV/c^2 and with a width of $(87\pm22(\mathrm{stat.}))$ MeV. The product branching ratio for this until now unknown resonance, named $Y(3940)$, is

$$\begin{aligned}&\mathrm{Br}(B\to Y(3940)K)\cdot\mathrm{Br}(Y(3940)\to\omega J/\psi)\\&=(7.1\pm1.3(\mathrm{stat.})\pm3.1(\mathrm{syst.}))\times10^{-5}\,.\end{aligned}$$

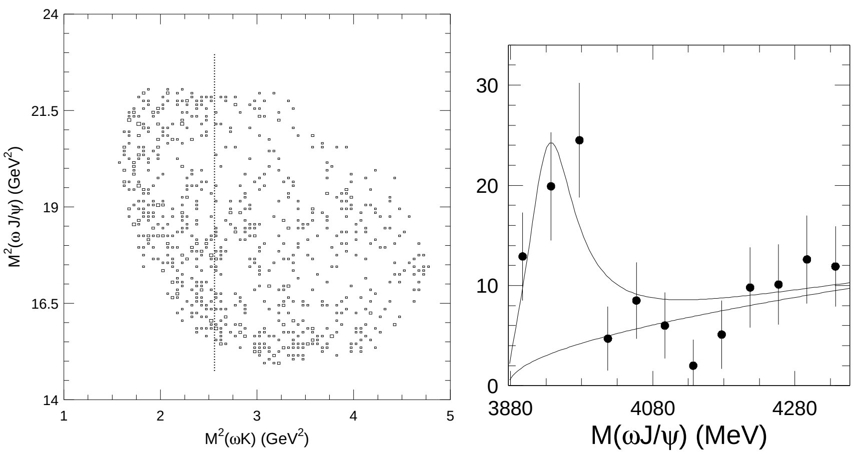

Fig. 6. Left: Dalitz plot of selected $B \to \omega J/\psi K$ decays. The vertical line shows the selected area. Right: B meson yield in $B \to \omega J/\psi K$ decays in bins of $M(\omega J/\psi)$.

5. $c\bar{c}$ recoil spectrum

The production of double charmonium states has been studied at Belle using the well established recoil mass method [18]. It consists of reconstructing one of the charmonium states, *e.g.* J/ψ, and calculating the mass recoiling against it according to $M_{\rm rec} = \sqrt{(E_{\rm CMS} - E_{J/\psi})^2 - p^{*2}_{J/\psi}}$. The spectrum of reconstructed recoil mass obtained from 285 fb^{-1} of data is shown in Fig. 7 [19]. A clear signals of η_c, χ_{c0} and $\eta_c(2s)$, the latter being

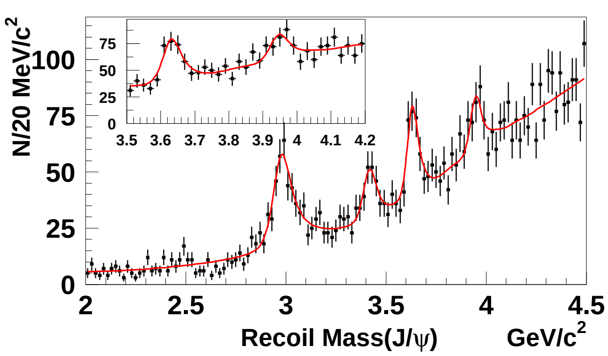

Fig. 7. Spectrum of the mass recoiling against the J/ψ. The inset shows a detailed view of higher $M_{\rm rec}$ interval.

a confirmation of the first observation by Belle [20], can be seen. At even higher $M_{\rm rec}$, above the $D\overline{D}$ threshold, another resonant structure was observed. The full line shows the result of the fit which includes the three above mentioned charmonium states with the MC determined shape, an additional resonance with a free position and width, and a background function which includes a possible $e^+e^- \to J/\psi D\overline{D}$ production. The fit yields 148 ± 33 events (stat. significance of 4.5 σ) at the mass of

$$M(X(3940)) = (3940 \pm 11(\text{stat.}))\ \text{MeV}/c^2\,.$$

The signal width of this $X(3940)$ state is found to be consistent with the experimental resolution on M_{rec}. A search for possible decays of $X(3940) \to D\overline{D}^*$ was performed by reconstructing an additional D meson beside the J/ψ and requiring the recoiling mass against the DJ/ψ system to be consistent with the $\overline{D}^*$ mass. A significant signal of $X(3940)$ is found and thus one concludes that this state is probably not the same as $Y(3940)$ enhancement in $M(\omega J/\psi)$ mass.

6. Pentaquark searches

Following the recent claims of various exotic states which could be interpreted as a possible pentaquark, Belle has performed a number of dedicated searches of such hadrons. Roughly they can be divided into a "high energy" and "low energy" searches. The former expression relates to the search in decays of B mesons or charmed hadrons, while the second exploits the secondary interactions in the material of the detector.

As an example of the search for pentaquarks in the decays of B mesons [21], the reconstructed ΔE distribution for $B^0 \to \overline{p}\pi^+D^-p$ decays is shown in Fig. 8. For events in the signal region (consisting of 303 ± 21 signal events) the mass of the D^-p is presented in the right plot. This distribution is fitted with a phenomenological function describing the background and a Gaussian signal positioned at the mass of 3099 MeV/c^2 corresponding to the mass of a claimed Θ_c^0 pentaquark [22]. The width of the signal part was fixed at 3.5 MeV, the estimated detector resolution. No statistically significant signal was found and the corresponding 90% C.L. upper limit on the production of Θ_c^0 relative to the $B^0 \to \overline{p}\pi^+D^-p$ branching ratio is placed at

$$\text{Br}(B^0 \to \Theta_c^0\overline{p}\pi^+)\cdot\text{Br}(\Theta_c^0 \to D^-p)/\text{Br}(B^0 \to \overline{p}\pi^+D^-p) < 1.2\%\,.$$

The search using interactions of charged and neutral kaons in the material of the detector represents a method which, regarding the energy of the interaction and particles involved, is very similar to some of the experiments claiming a positive pentaquark signal [23]. First, the common vertices of identified $K_{\text{S}}p$ and $K^\pm p$ pairs, separated from the interaction point, are searched for. By plotting the coordinates of these vertices in the plane perpendicular to the e^+e^- beams, one obtains a nice "tomographic" picture of

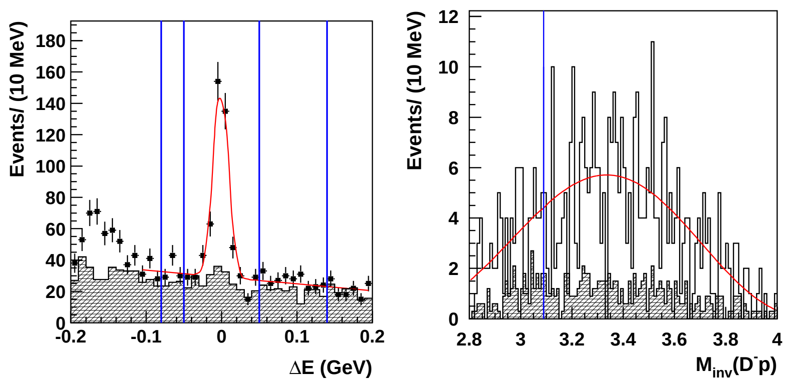

Fig. 8. Left: ΔE distribution of $B^0 \to \overline{p}\pi^+ D^- p$ decays. Right: Invariant mass of $D^- p$ for events in ΔE signal region. Full line is the result of the fit described in the text.

the detector, shown in Fig. 9 (left). It reflects the distribution of the material in the detector where the beam pipe, ladders of SVD and the support structure of the CDC are clearly visible, assuring that the vertices found indeed correspond to the pK pairs produced in secondary interactions. The projectile inducing a secondary interaction being a kaon is assured by examining the distance between the position of the secondary vertex and the next closest track (apart from the p and K). The fraction of other tracks at the vertex which are positively identified as kaons is negligible. It is thus reasonable to conclude that the secondary interactions (assuming the strangeness conservation) are in a large majority induced by strange projectiles. Next, the invariant mass of the secondary pairs is calculated and presented in Fig. 9 (right). In the $M(pK^-)$ distribution a large signal of $\Lambda(1520)$ is visible. The distribution is fitted with a threshold function and a D-wave Breit–Wigner term convolved with the experimental resolution (2 MeV/c^2). The resulting parameters of $\Lambda(1520)$ are in agreement with the world average values. The distribution for the $K_{\rm S}p$ pairs is fitted with a 3rd order polynomial and a narrow signal positioned at different values of $M(K_{\rm S}p)$. For $M(K_{\rm S}p) = 1540$ MeV/c^2, the mass of the claimed Θ^+ pentaquark [23], the resulting signal yield is 29 ± 65 events. Assuming $\mathrm{Br}(\Theta^+ \to pK_{\rm S}) = 25\%$, $\mathrm{Br}(\Lambda(1520) \to pK^-) = 1/2\ \mathrm{Br}(\Lambda(1520) \to N\overline{K})$, and evaluating the ratio of efficiencies for $\Theta^+ \to pK_{\rm S}$ and $\Lambda(1520) \to pK^-$ from MC, one arrives at the upper limit for Θ^+ production

$$\frac{\sigma(KN \to \Theta^+ X)}{\sigma(\overline{K}N \to \Lambda(1520)X)} < 2\% \quad at \quad 90\%\mathrm{C.L.} \qquad (1)$$

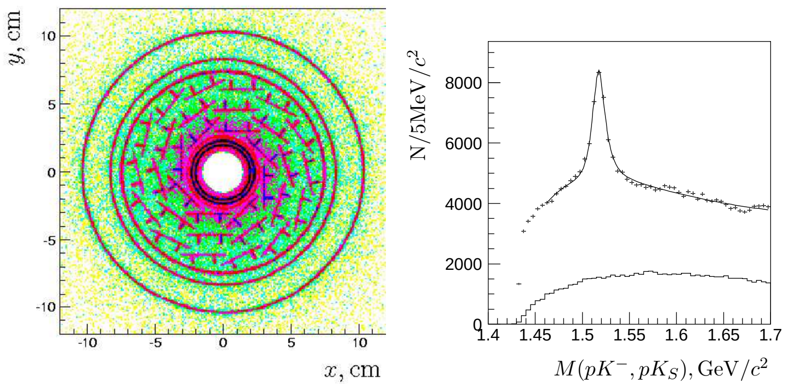

Fig. 9. Left: Position of the secondary pK vertices in the plane perpendicular to the beam. Right: Distribution of the secondary pairs invariant mass for pK^- (upper) and $pK_{\rm S}$ (lower).

7. Conclusion

e^+e^- collisions at the KEKB accelerator prove not only to be a dedicated source for measuring the CP violation phenomena in the system of B mesons but also an interesting ground for exploration of hadron spectroscopy. Nu-

TABLE I

Some of the searches and discoveries of new hadronic states by Belle collaboration.

state	production	decay mode	reference
D_{sJ}	continuum	$D_s\pi^0$, $D_s^*\pi^0$	[6]
	$B \to DD_{sJ}$	$D_s\gamma$	[7], [11]
	$B \to D_{sJ}K$		[10]
$X(3872)$	$B \to XK$	$\pi^+\pi^- J/\psi$	[14]
		$\pi^0\pi^+\pi^- J/\psi$	[15]
$Y(3940)$	$B \to YK$	$\omega J/\psi$	[17]
$X(3940)$	continuum, $c\overline{c}$ recoil	$M_{\rm rec}$, DD^*	[19]
$\eta_{\rm c}(2s)$	continuum, $c\overline{c}$ recoil	$M_{\rm rec}$	[18] [19]
$\Sigma_{\rm c}(2800)$	continuum	$\Lambda_c\pi^+$	PRL94,122002
broad D^{**}	$B \to D^{**}\pi$	$D^{(*)}\pi$	PRD69,112002
			hep-ex/0412072
$\Lambda_c\overline{p}$	$B^- \to \Lambda_c\overline{p}\pi^-$	$M(\Lambda_c\overline{p})$	hep-ex/0409005
$\Theta(1540)^+$	sec. int. pK	$pK_{\rm S}$	hep-ex/0411005
Θ^+, Θ^{*++}	B decays	$pK_{\rm S}$, pK^+	hep-ex/0411005
Θ_c^0, Θ_c^{*+}		$D^{(*)-}p$, D^0p	

merous measurements of hadron properties were performed and only some of the unexpected and puzzling discoveries were briefly covered in the present paper. Recently it seems the understanding of hadron structures in terms of QCD has been put under test not only by the uprise of possible pentaquark states (where the experiments including Belle reporting negative search results seem to outnumber those claiming a positive one, nevertheless the puzzle not being solved) but also by discoveries of new states with either some unexplained properties (D_{sJ} mesons), yet undetermined quark structure ($X(3872)$) or simply by being unexpected ($Y(3940)$, $X(3940)$). Table I lists some of the measurements in the field of hadron spectroscopy performed by the Belle collaboration together with references to further reading.

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